HELSINKI UNIVERSITY OF TECHNOLOGY

Convergence of communication services

Lecture slides for S-38.3192

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Contents

- Services and contemporary networks
  - IP service
    - Voice over IP
    - Data over IP
- Convergence
  - Everything over IP
- Convergence is _almost_ the same as QoS in the Internet
  - However, QoS is more of a technical matter whereas convergence is also loaded with business aspects

Goals of this lecture

- After this lecture you should
  - Be able to define and explain convergence in telecommunication networks
  - Be able to understand networks and services from the points of view of the customer and the operator
  - Be able to explain services and the technical requirements they set for the network
  - Be able to explain how contemporary IP networks support different services today, and what requirements need to be fulfilled to support them also tomorrow

Services – user point of view

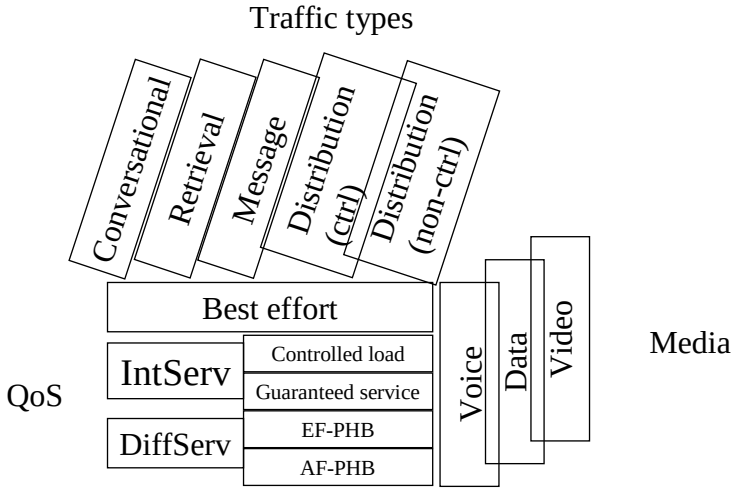
- PSTN
  - POTS, fax
- Broadcast services
  - radio, TV (maybe also interactive TV)
- Data services
  - email, file transfer: INTERNET

Services – service provider point of view

- Suitable network for each customer service
  - Circuit switched network for PSTN
    - And wireless solutions (GSM/UMTS) for mobile services
  - Broadcast network for TV and radio
    - remember also cable-TV and satellite-TV
  - Networks for data services
    - PSTN-network, hybrid PSTN/xDSL-networks, leased lines, WLANs, GPRS, etc.

Convergence means that there should be just one (logical) network for all services!

ITU-T Y.1001 application/service model



"Standardized convergence"

- ITU-T has produced recommendation Y.1001 that suggests the IP framework for the convergence platform.
- One of the key concepts is Application/Service model
  - reflects the relationship between customers and IP networks

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Convergence – definitions

- The idea is to have just one (logical) network that handles all communication traffic
  - TV, Radio, Telephone, Data etc.
- At this moment the emphasis is on joining data and telephone services
  - Due to high IP penetration, convergence is proposed to happen (converge to) in the Internet

Convergence notes

- Data seems to be running on every possible platform with enough reliability
- Radio and TV would seem to require a high-quality network with large bandwidth
- Voice transfer requires delay bounds and control on delay variation

We need a *reliable* network with the possibility for guaranteed *bandwidth* and strict *delay control*!

Technical service requirements

- Capacity or bandwidth (or transmission speed)
  - TV/Multimedia typically has high bandwidth requirements
- Delay bounds
  - Telephony needs short delays and small variations in delay, not that much bandwidth, however.
- Reliability
  - Data typically needs reliable connections
    - Bandwidth is a plus, but not a necessity

More capacity

- Core networks
  - Updates are easy and manageable
  - Need to use the latest technology -> relatively expensive
    - Except ethernet solutions
  - WDM etc.
- User access
  - Uncontrolled updates, numerous technologies
  - xDSL, modems, ISDN, cable, Ethernet, Wireless
  - Usually limited (and differentiated) in bandwidth

Controlled delay

- Control the use of resources (buffer space in routers)
  - Admission control (user access)
  - Traffic shaping/policing (core network)
  - Directionality of the traffic flows (core network / routing)
- Introduces a new concept to the Internet
  - Controlled access with core taking part in traffic control

Reliable delivery

- Separate different traffic types
  - traffic differentiation
- Dimension network buffers and control the access to the resources
  - Effects on delay have to be considered
- Update the user access technologies to more reliable ones

Existing Internet infrastructure

- IP routers
  - no wide-spread capability to provide for traffic or admission control yet
  - plain best effort service
- TCP and UDP protocols
  - for data service
- RTP to provide for end-to-end preservation of real-time properties
  - for IP telephony, video delivery

IP routers at the moment

- MOstly FIFO-queuing (possibility for other methods)
  - Operators are not willing (or able) to use their routers' potential!
- No stored information on future or past packets
- Distributed route calculation
  - Each router makes individual routing/forwarding decisions

New Internet router functionality

- Service classes beyond best effort need:
  - QoS routing
    - balanced use of network resources
  - Admission control
    - Long-term predictable use of network resources
  - Traffic control
    - Short-term predictable use of network resources

TCP/UDP protocols

- TCP
  - Adaptive end-to-end protocol
    - adapts to network congestion and available resources based on received acknowledgements
  - No fixed sending speed possible
    - rwnd, in theory
- UDP
  - No end-to-end control
  - Identifies the application
  - Possibility to use for malicious purposes
    - attacks to router queues

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RTP/RTCP protocol

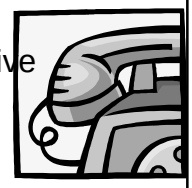
- Works over UDP
- Controls the sending speed
- Enables the recreation of the temporal properties of the original data stream
  - Timestamps, reception buffers
- Used in VoIP, multicast applications

IP as the convergence network technology

- Existing infrastructure
  - proved scalability
- Update to IPv6
  - provides support for the increase in host count
- Almost no support for QoS
  - No admission control and no traffic control
    - IP routers do not maintain state
- *We need a technology that works with IP and provides for QoS!!*

QoS architectures

- Integrated Services (IntServ)
  - Per-flow, end-to-end solution with quantitative QoS
  - Scalability & Traffic management problems
  - RSVP as the reservation protocol
  - Not a very realistic choice



- Differentiated Services (DiffServ)
  - Offers different service levels to traffic aggregates, i.e. qualitative QoS for individual users
  - Technically very feasible solution
  - Difficulty of marketing, only CoS available to the individual user

Reality check on networking

- Core technologies are diverse
- IP QoS is only just starting
- Core networks can not handle *all* existing services
  - Not enough capacity
  - However, for now, they handle offered traffic reasonably well

Convergence path

- Voice over IP
  - existing solutions, voice traffic is estimated to be the minority traffic compared to data traffic
  - moderate requirements on bandwidth, strict on delay
- TV over IP
  - multicasting is a functioning part of the current Internet
  - High-quality video can not be supported due to high bandwidth demands

1 Mbit/s available, choose one from the following:

•40 customers with VoIP á 25 kbit/s and 3 minutes a call for 1€ (that's 40€)

•2 customers with IPTV (different channels) á 500 kbit/s and 60 minutes for 10€ (that's 20€)

Reality check on convergence

Thesis:

If the service already has an existing platform and infrastructure it is not probable that this service is moved over another infrastructure that may or may not support the service demands and requirements.

Addendum:

No matter how sexy it would be...

Probable convergence incentives

- End-device convergence
  - Everything goes mobile!
- New (& unforeseen) service requires more from the network
  - and is used by all
- Negative incentives are dealt with
  - Copyright issues in P2P, for instance
- And at least #1, #7, #8, #9 and #10 from RFC 1925.

Convergence summary

- Idea: Put everything into one network and save the management costs of several networks
  - However the cost of updating the current network to support everything is, for the moment, more costly than managing several networks
- In the Internet, the convergence means, from the technical viewpoint, bringing the ability to differentiate traffic into several service classes with deterministic behavior.
  - QoS!!

Immediate actions to be taken

- Sign up for the final exam!
  - Exam dates 9.3.2007, 9-12, S1
    - Next 15.5.2007 16-19, S4
    - There will probably a third exam in Fall 2007 term, but most probably not fourth one.
- One of the course requirements is to GIVE FEEDBACK. So, GIVE FEEDBACK!!
  - http://palaute.ee.hut.fi/lomake.php?id=704&axn=1
- Remember, your exercise work is valid only until the next instance of this course begins
  - So, prepare well for the exams!!